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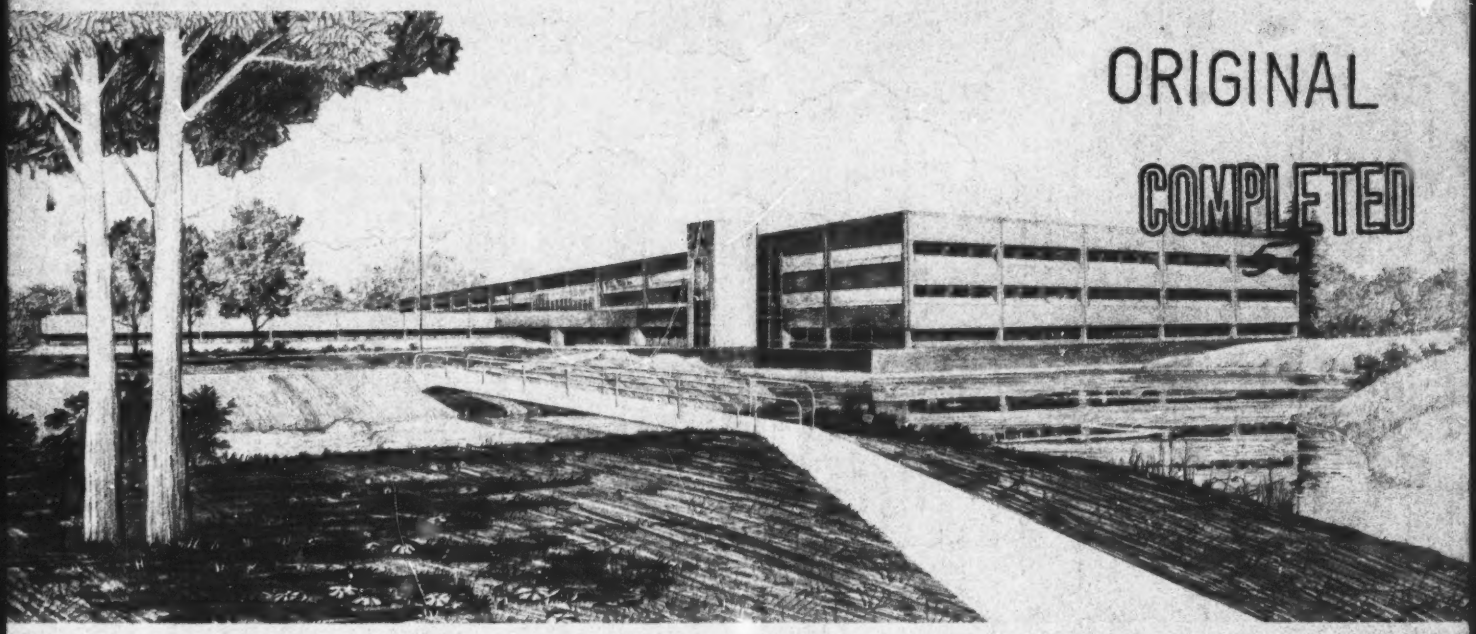

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Experiment Data Report for Semiscale MOD-2A Small Break Test Series (Tests S-UT-6 and S-UT-7)

Ronald A. Larson
L. Bruce Clegg

November 1981

Prepared for the
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Under DOE Contract No. DE-AC07-76IDO1570
FIN No. A6038

EG&G Idaho

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-2A SMALL BREAK TEST SERIES (TESTS S-UT-6 AND S-UT-7)

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ABSTRACT

This report presents recorded test data for Tests S-UT-6 and S-UT-7 of the Semiscale Mod-2A Small Break Test Series. These are two of several Semiscale Tests that investigate the thermal-hydraulic phenomena resulting from a small-break loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR) system. These tests give experimental data for assessing the analytical capability of computer codes used in LOCA analysis.

The primary objective of Tests S-UT-6 and S-UT-7 is to give comparative data from a small break LOCA with and without upper head injection (UHI). The influence of emergency core coolant (ECC) water injected into the upper head on the vessel flow behavior and the resultant core cooling will be of particular interest.

Tests S-UT-6 and S-UT-7 were conducted from initial conditions closely approximating the specified initial conditions of 15.5 MPa system pressure; 557 K cold-leg temperature; and 2.0 MW core power level. This report gives comparison of uninterpreted data from Tests S-UT-6 and S-UT-7 for future analysis. The data, presented in the form of graphs in engineering units, has been analyzed only to the extent necessary to ensure that they are reasonable and consistent.

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SUMMARY

Tests S-UT-6 and S-UT-7 are part of the Semiscale Mod-2A portion of the Semiscale Program conducted by EG&G Idaho, Inc., for the United States Government. More specifically, they are part of the Mod-2A Small-Break Test Series that investigates the thermal-hydraulic phneomena resulting from a small-break loss-of-coolant accident (LOCA) in a pressurized water reactor (PWR) system. They provide experimental data that can be used to assess the analytical capability of computer codes used in LOCA analysis. The primary objectives of Tests S-UT-6 and S-UT-7 are to provide comparative data from a small cold-leg break (LOCA) with and without upper head injection (UHI). Of particular interest will be the influence of emergency core coolant (ECC) water injected into the upper head on the vessel flow behavior and the resultant core cooling.

The Mod-2A system is equipped with a pressure vessel which contains an electrically heated core with other simulated reactor internals such as an external downcomer assembly; an intact loop with steam generator, pump, and pressurizer; a broken loop with steam generator, pump, break simulator; and a break effluent condensing system with blowdown valve, a vertical downflow condenser and two condensate drain tanks; and a steam supply system. High-pressure and low-pressure coolant injection pumps and a coolant injection accumulator were provided for the intact loop and broken loop. In addition, Test S-UT-7 was equipped with a coolant injection accumulator for the vessel upper head. The specified initial conditions for Tests S-UT-6 and S-UT-7 included a system pressure of 15.5 MPa, and a core inlet temperature of 557 K with a core differential temperature of 37 K. The simulated small break (volume-scaled to represent 5% of the area of a cold leg pipe of a PWR) is on the centerline of the broken loop pipe between the pump and the vessel. After initiation of blowdown, power to the electrically heated core was reduced to simulate the predicted heat flux response of nuclear fuel rods during a LOCA.

Generally, Tests S-UT-6 and S-UT-7 proceeded as specified. Conditions which did not conform to the specified test configuration were acceptable for analysis purposes within the test objectives. Of 298 measurements taken for Tests S-UT-6 and S-UT-7, respectively, 256 and 260 produced usable data.[a]

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a. These data are available from the NRC/RSR Data Bank at the Idaho National Engineering Laboratory. Address inquiries to EG&G Idaho, Inc., P.O. Box 1625, Idaho Falls, Idaho 83415.

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EXPERIMENT DATA REPORT FOR SEMISCALE MOD-2A SMALL-BREAK TEST SERIES (TESTS S-UT-6 AND S-UT-7)

I. INTRODUCTION

The Semiscale Mod-2A experiments represent the current phase of the Semiscale Program conducted by EG&G Idaho, Inc., for the United States Government. The program, sponsored by the Nuclear Regulatory Commission through the Department of Energy, is part of the overall NRC program to investigate the response of a pressurized water reactor (PWR) system to a hypothesized loss-of-coolant accident (LOCA). The underlying objectives of the Semiscale Program are to quantify the physical processes controlling system behavior during a LOCA and to provide an experimental data base for assessing reactor safety evaluation models. The Semiscale Mod-2A Program has the further objective of supporting other experimental programs in the form of instrumentation assessment, optimization of test series, selection of test parameters, and evaluation of test results.

Tests S-UT-6 and S-UT-7 were conducted April 16, and 22, 1981, in the Semiscale Mod-2A system as part of the Small-Break Test Series. This series investigates the thermal-hydraulic phenomena resulting from a small-break LOCA in a PWR system and produces experimental data with which to assess the analytical capability of computer codes to predict PWR system behavior during a small-break LOCA. The primary objectives of Tests S-UT-6 and S-UT-7 are to provide comparative data from a small, cold-leg break (LOCA), with and without upper head injection (UHI). The influence of emergency core coolant (ECC) water injected into the vessel upper head on the vessel flow behavior and resultant core cooling is of particular interest.

This report presents the test data in an uninterpreted but readily usable form for use by the nuclear community in advance of detailed analysis and interpretation. Section II briefly describes the system configuration, procedures, initial test conditions, and events that are applicable to Tests S-UT-6 and S-UT-7; Section III gives the data graphs, comments, and supporting information necessary for interpretation of the data. A description of the overall Semiscale Program as well as a more detailed description of the Semiscale Mod-3 system are in References 1 and 2. Additional information describing data acquisition system capabilities, posttest adjustments made to the data, and the methodology used to establish uncertainty limits are given in Appendix A.

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II. SYSTEM PROCEDURES, CONDITIONS, AND EVENTS FOR TESTS S-UT-6 AND S-UT-7

System Configuration

The Semiscale Mod-2A system for these tests consists of a pressure vessel with simulated reactor internals, including a 25-rod core with electrically powered rods and an external downcomer assembly; an intact loop with pressurizer, steam generator, and pump; and a broken loop with a steam generator, pump, and rupture assembly. The system also has emergency core coolant (ECC) from high- and low-pressure injection pumps for each loop; coolant injection accumulators for the intact loop and broken loop, a break effluent condensing system, and steam supply system. In addition, Test S-UT-7 was equipped with a coolant injection accumulator for the vessel upper head. Reference 1 further describes the Semiscale system.

Figures 1 and 2 show the system configuration for these tests. Reference 2 describes the communicative break simulator configuration with break nozzle near loop piping.

Twenty-three rods of the 25-rod core were operated at a rod peak axial power density of 36.85 kW/m, thus providing a total core power of 2.0 MW. Two of the 25 rods were unpowered.

The break effluent condensing system includes a 3/4 inch air operated on-off valve, a vertical downflow condenser and two condensate drain tanks. Figure 3 shows the condensing system configuration.

The heat loss makeup for the Mod-2A system is composed of numerous heater bands and tapes on both the intact loop and broken loop piping. The heaters were controlled by five variable power supplies; intact loop hot leg, cold leg, pump suction, broken loop hot and cold legs and pump suction. A total operating capacity of the system is approximately 51 kW.

Test Preparation

In preparing for the two tests, the system was filled with treated demineralized water and vented at strategic points to ensure a liquid-full system. Treated demineralized water in the steam generator feedwater tank was heated to 495 K, and the required liquid levels were established in the steam generator secondary sides. Before warmup, the system was checked for leakage, and system instrumentation checkout was performed.

Warmup

Warmup to initial test conditions was accomplished with the core heaters. During warmup, the purification and sampling systems were valved into the primary system to maintain water chemistry requirements at system conditions for subsequent analysis. During warmup, detector readings were sampled at 50 K temperature intervals to check the integrity of the measurement instrumentation and the performance of the data acquisition system.

Test Sequence

The accumulators for the intact and broken loop for Tests S-UT-6 and S-UT-7 and the accumulator for the vessel upper head injection for Test S-UT-7 were filled with treated demineralized water, drained to specified levels and pressurized with nitrogen. The intact and broken loop accumulators were pressurized to 2.9 MPa and the upper head accumulator was pressurized to 8.6 MPa. The core power was increased to a nominal 2.0 MW. Initial test conditions were achieved and held for approximately 262 and 268 s for Tests S-UT-6 and S-UT-7, respectively, to establish system equilibrium. All auxiliary systems were isolated at the end of this period to prevent blowdown through these systems. The test was initiated by opening the blowdown valve downstream of the break orifice to break the system pressure boundary. A successful simulated small cold-leg break, through a break simulator assembly in the broken loop having a total break area of 0.1123 cm^2, was accomplished. The break assembly is further described in Reference 3.

During blowdown, the effluent was ejected from the primary system to the condensing system with two condensate drain tanks, each with remotely operated fill and drain valves. At blowdown, the intact and broken loop primary pumps continued to operate until 3.4 s after the

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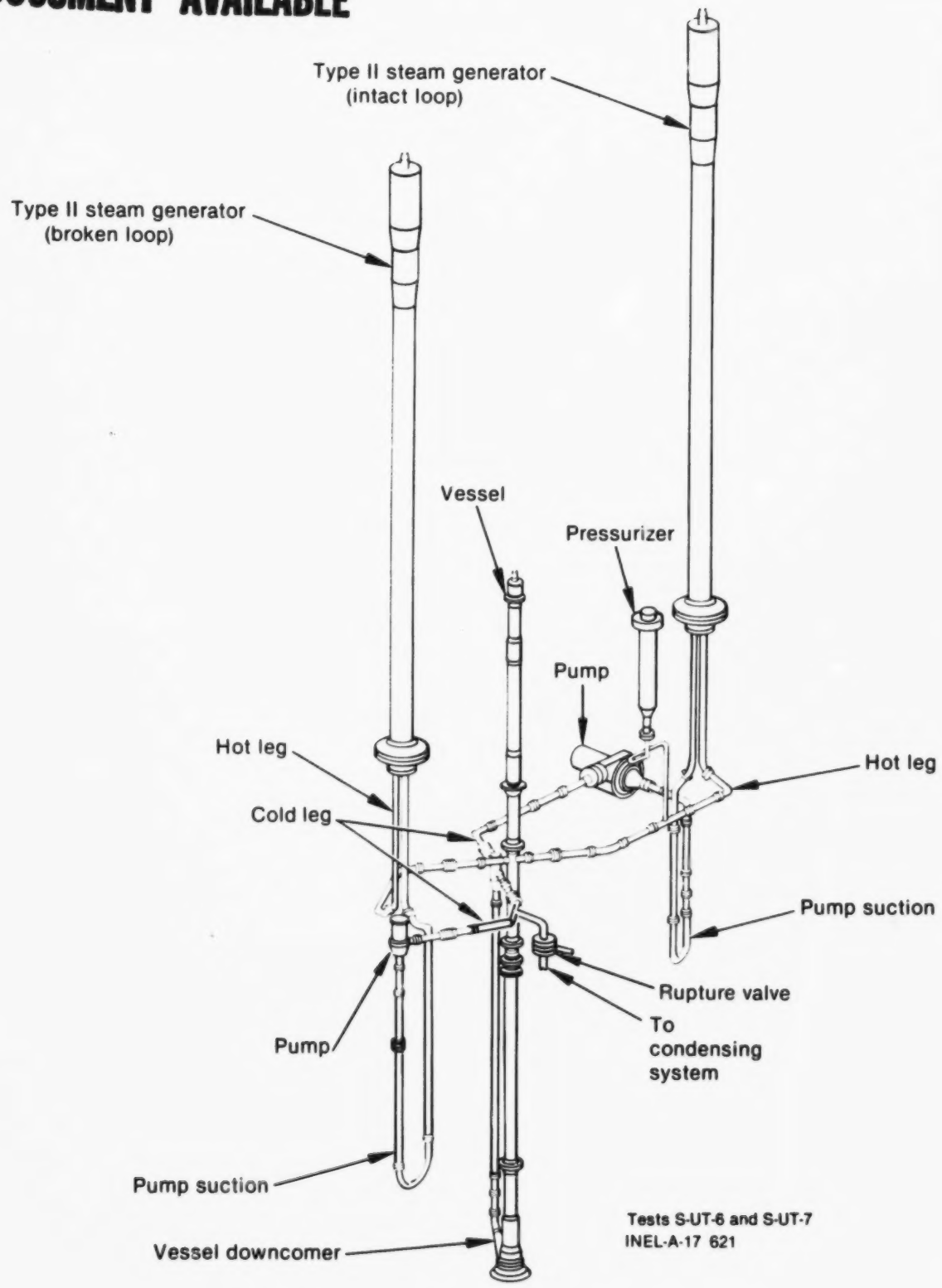

Figure 1. Semiscale Mod-2A system for cold leg break configuration—isometric.

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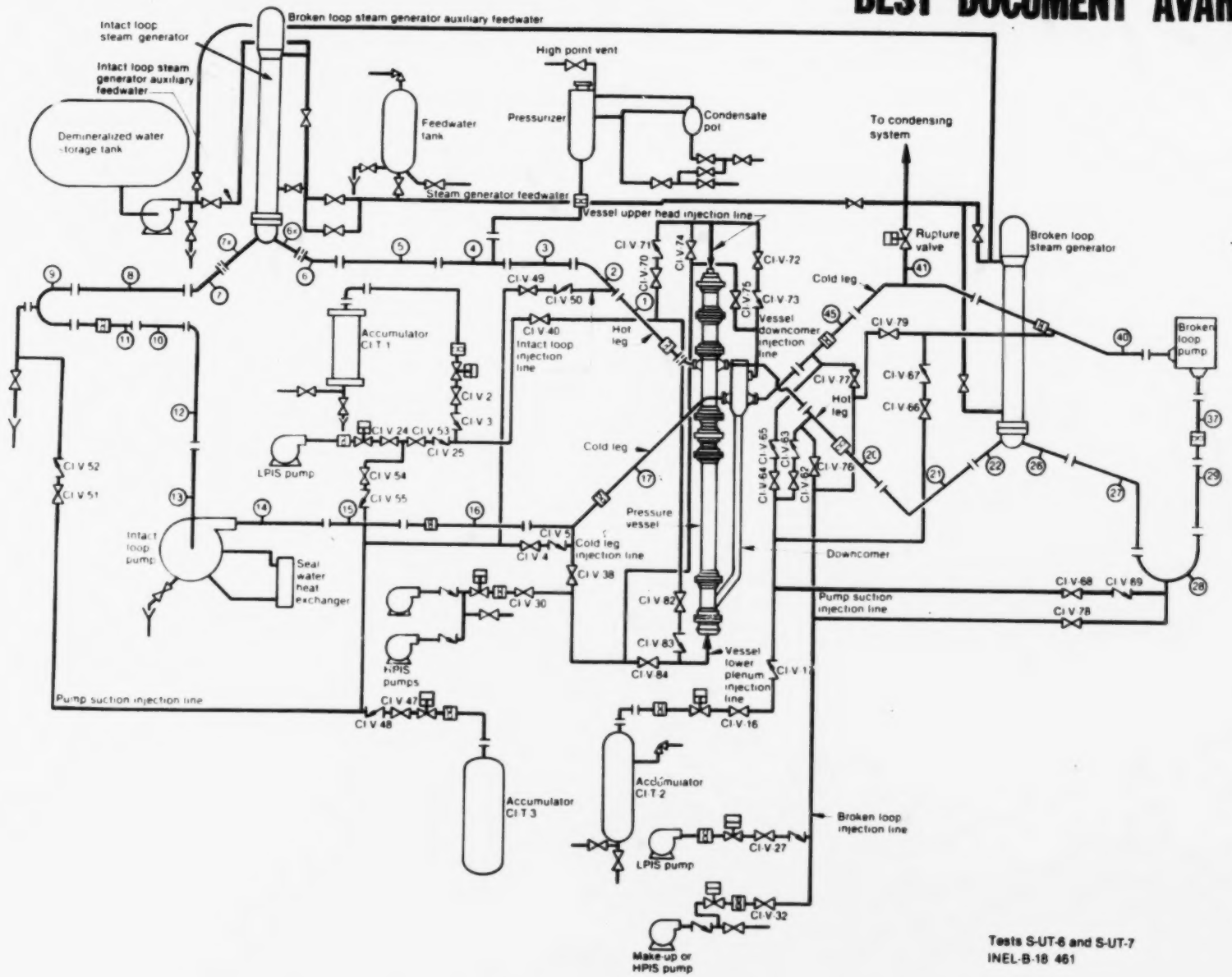

Figure 2. Semiscale Mod-2A system for cold leg break configuration—schematic.

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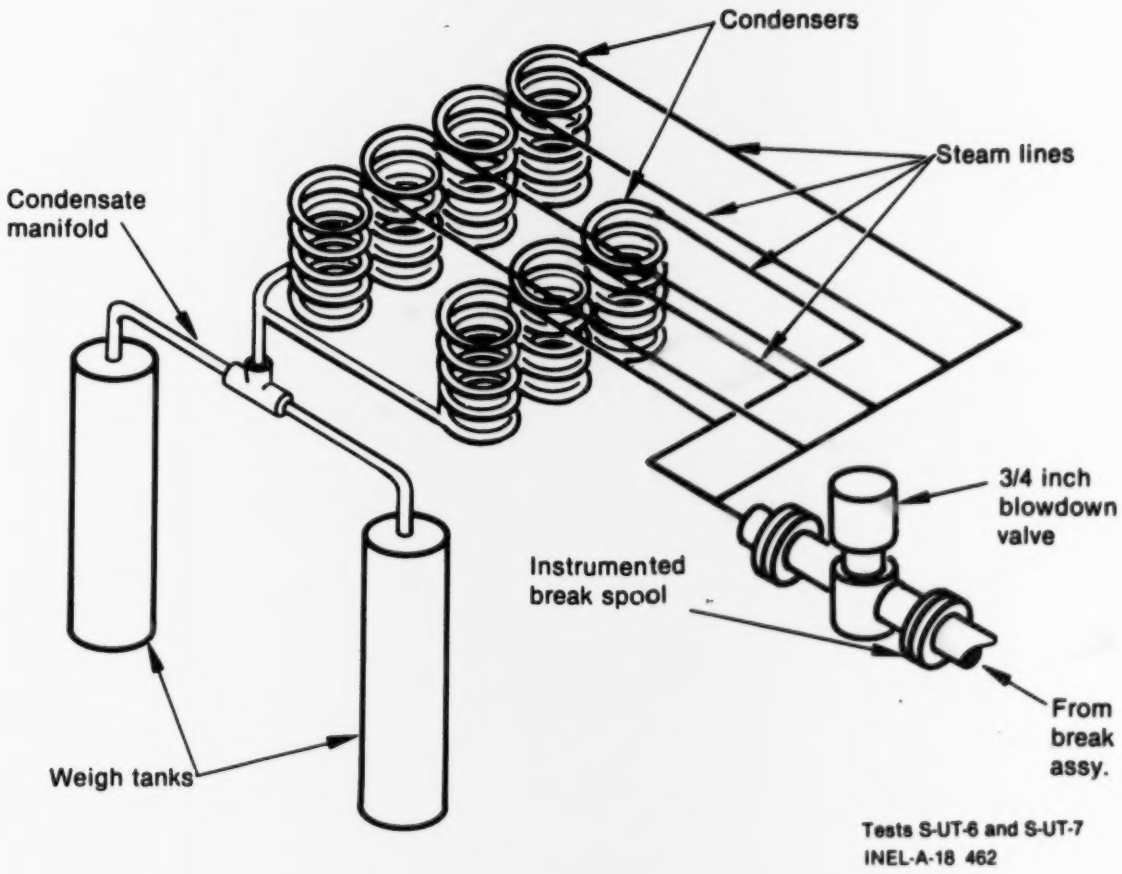

Figure 3. Semiscale Mod-2A condensing system—schematic.

pressurizer pressure reached 12.6 MPa (see Table 3). At this time, the pumps followed a predetermined speed profile for 120 s for the intact loop pump and 60 s for the broken loop pump, after which power was tripped and the pumps were allowed to coast down. During the blowdown, transient power to the electrically heated core was automatically controlled to simulate the thermal decay response of nuclear fuel rods.

For Tests S-UT-6 and S-UT-7, the coolant injection systems were arranged to discharge into the cold leg of the intact and broken loops. However, the broken loop high-pressure and low-pressure injection pump was mistakenly not operated. Since a single pump is used in each loop to simulate the high-pressure and low-pressure systems, the low-pressure injection rate is simply added to the high-pressure injection flow rate for pressure below 0.98 MPa. The high-pressure injection started 36 s after blowdown for S-UT-6 and S-UT-7 with a nominal flow rate of 0.027 L/s. The injection pumps, once started, continued for the duration of the test.

The intact loop and broken loop coolant injection accumulators for Test S-UT-6 started 730 s and 750 s after blowdown initiation and continued for 2800 and 1250 s, respectively. Total volume injected was 0.045 m^3 for the intact loop accumulator and 0.013 m^3 for the broken loop accumulator. Test S-UT-7 the coolant injection accumulators started 822 s after blowdown initiation and continued for 3730 s for the intact loop and 738 and 1810 s for the broken loop. Total volume injected was 0.0456 m^3 for the intact loop accumulator and 0.0136 m^3 for the broken loop accumulator. The vessel upper head injection accumulator, Test S-UT-7 only, started injection 21 s after blowdown initiation and continued for 296 s. Total volume injected was 0.0299 m^3.

Tabular Data for Test Conditions

Tables 1 and 2 show conditions in the Semiscale Mod-2A system at initiation of blowdown. Table 3 given the sequence of events relative to rupture.

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Table 1. Conditions at blowdown initiation

	Measured[a]		Specified
	Test S-UT-6	Test S-UT-7	Tests S-UT-6 and S-UT-7
Core power (MW)	1.992	1.994	2.0 ± 0.05
System pressure (MPa)	16.03	15.45	15.50 ± 0.20
Intact loop cold leg fluid temperature (K)	557	558	557 ± 2
Broken loop cold leg fluid temperature (K)	557	559	557 ± 2
Intact loop hot leg to cold leg temperature differential (K)	41	41	37 ± 2
Broken loop hot leg to cold leg temperture differential (K)	40	39	37 ± 2
Intact loop cold leg flow (L/s)	9.4	9.4	--[b]
Broken loop cold leg flow (L/s)	3.7	3.6	--[b]
Steam generator feedwater temperature[c] (K)			
Intact loop	504	502	495 ± 2
Broken loop	504	497	495 ± 2
Intact loop steam generator liquid level (cm above top of tube sheet)	749	754	--[d]
Broken loop steam generator liquid level (cm above top of tube sheet)	853	725	--[d]

a. Measured initial conditions are taken from digital acquisition system read just prior to blowdown initiation.

b. Flow is not specified since it must be adjusted to achieve the required differential temperature across the core.

c. One source of feedwater for both intact and broken loops.

d. Liquid level was not specified. New steam generators had been installed in both operating loops and the most efficient operating level had not been determined.

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Table 2. Primary coolant temperature distribution before rupture[a]

	Detector	Temperature (K) Test S-UT-6	Test S-UT-7
Intact loop hot leg (near vessel)	TFI*1	598	599
Intact loop cold leg	TFI*11	559	560
Intact loop cold leg (near downcomer)	TFI*17	557	558
Broken loop hot leg (near vessel)	TFB*20	596	597
Broken loop cold leg (near downcomer)	TFB*45	556	558
Downcomer (near top)	TFV*DC-84	558	559
Downcomer (middle)	TFV*DC-270	558	559
Downcomer (near bottom)	TFD*DC-435	554	555
Core (top of heated length)	TFV*A4+366	600	601
Core (middle of heated length)	TFV*B3+166	580	581
Core (bottom of heated length)	TFV*D4+6	561	562

a. Average of data taken from -20 s to -3.0 s before blowdown initiation.

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Table 3. Sequence of events

Event	Time Relative to Rupture (s)	
	Test S-UT-6	Test S-UT-7
Core power level established	-262	-268
Makeup pump and pressurizer heaters off	-2.5	-2.5
Pressurizer pressure equal to 12.57 MPa	10.3	8.6
Steam valves on steam generators close	10.3	10.8
Core power decay starts	12.6	12.4
Feedwater valve on steam generator closed (BL)	34	34
Feedwater valve on steam generator closed (IL)	34	34
HPIS injection starts	35.2	34
Broken loop pump tripped off	67	72.5
Intact loop pump tripped off (start of coastdown)	134	133
Core powe cerminated	5198	4575

III. DATA PRESENTATION

This section presents the data from Semiscale Mod-2A Tests S-UT-6 and S-UT-7 with brief comment. Processing analysis serves only to obtain appropriate engineering units and to ensure that data are reasonable and consistent. In all cases, analysts assumed a homogeneous fluid in converting transducer output to engineering units. Further interpretation and analysis should consider that sudden decompression processes such as those occurring during blowdown may have subjected the measurement device to nonhomogeneous fluid conditions.

The performance of the system during Tests S-UT-6 and S-UT-7 was monitored by 298 detectors. A digital data acquisition system recorded data for Tests S-UT-6 and S-UT-7 at an effective sample rate of 3.333 points per second per channel.

The data appear in some instances in the form of composite graphs to facilitate comparison of the values of given variables. The scales selected for the graphs do not reflect the obtainable resolution of the data. (Reference 1 and Appendix A describe the data processing techniques further.)

Figures 1 through 8 give information for interpretation of the data graphs. Table 4 groups the measurements according to type, identifies the location and range of the detector and actual recording range of the data acquisition system, provides brief comments regarding the data, and references the detector and comments to the corresponding figure.

Figures 9 through 330 (data graphs) present all the blowdown data obtained. Time zero on the graphs is the time of rupture initiation. Appendix A provides information explaining the data acquisition system capabilities and a guide to the uncertainty associated with data measurements in the Semiscale Mod-2A system.

Data plots (Figures 9 through 330) and the appendix are on microfiche attached to the inside of the back cover.

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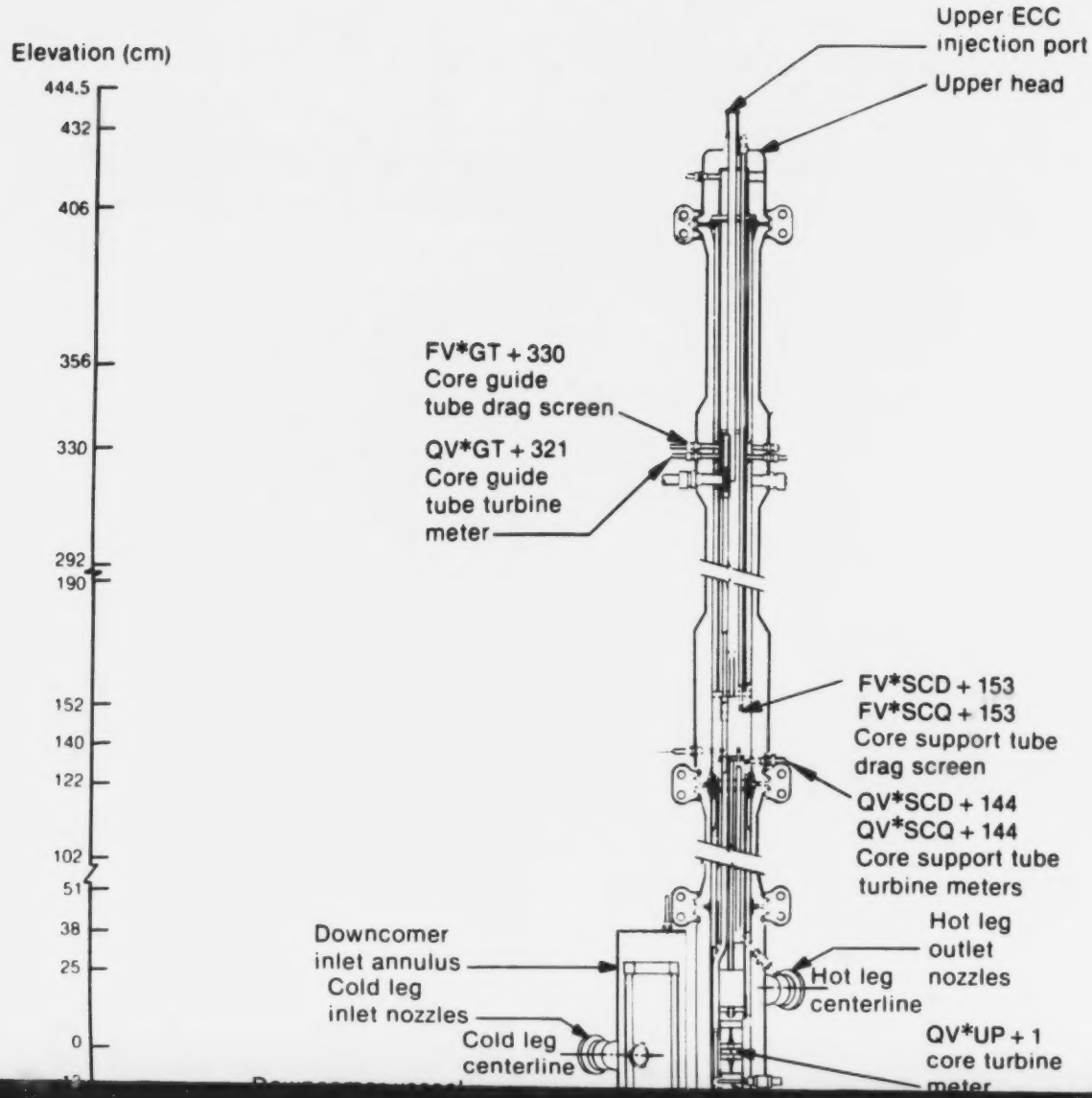

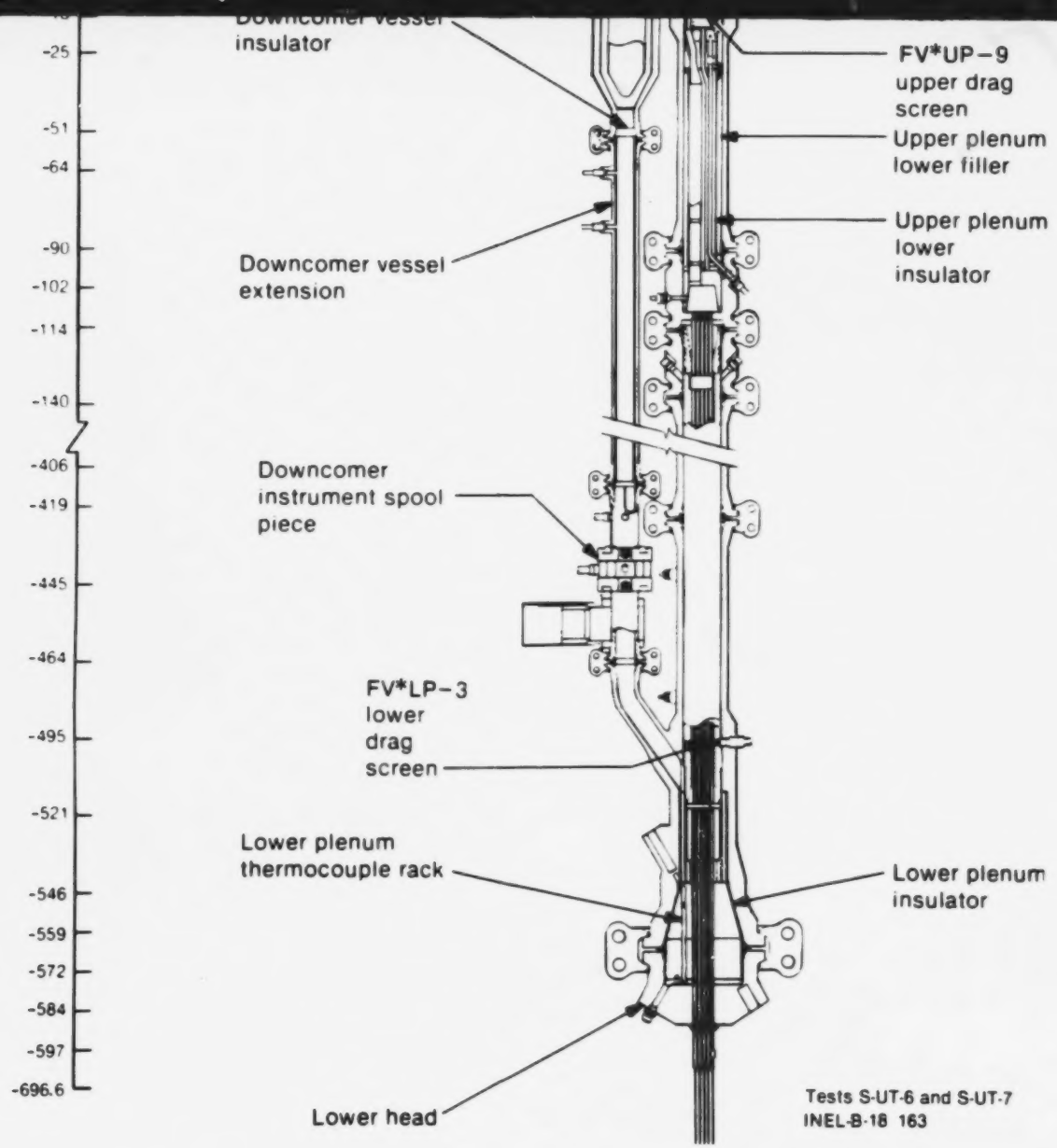

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Figure 4. Semiscale Mod-2A pressure vessel and downcomer—cross section.

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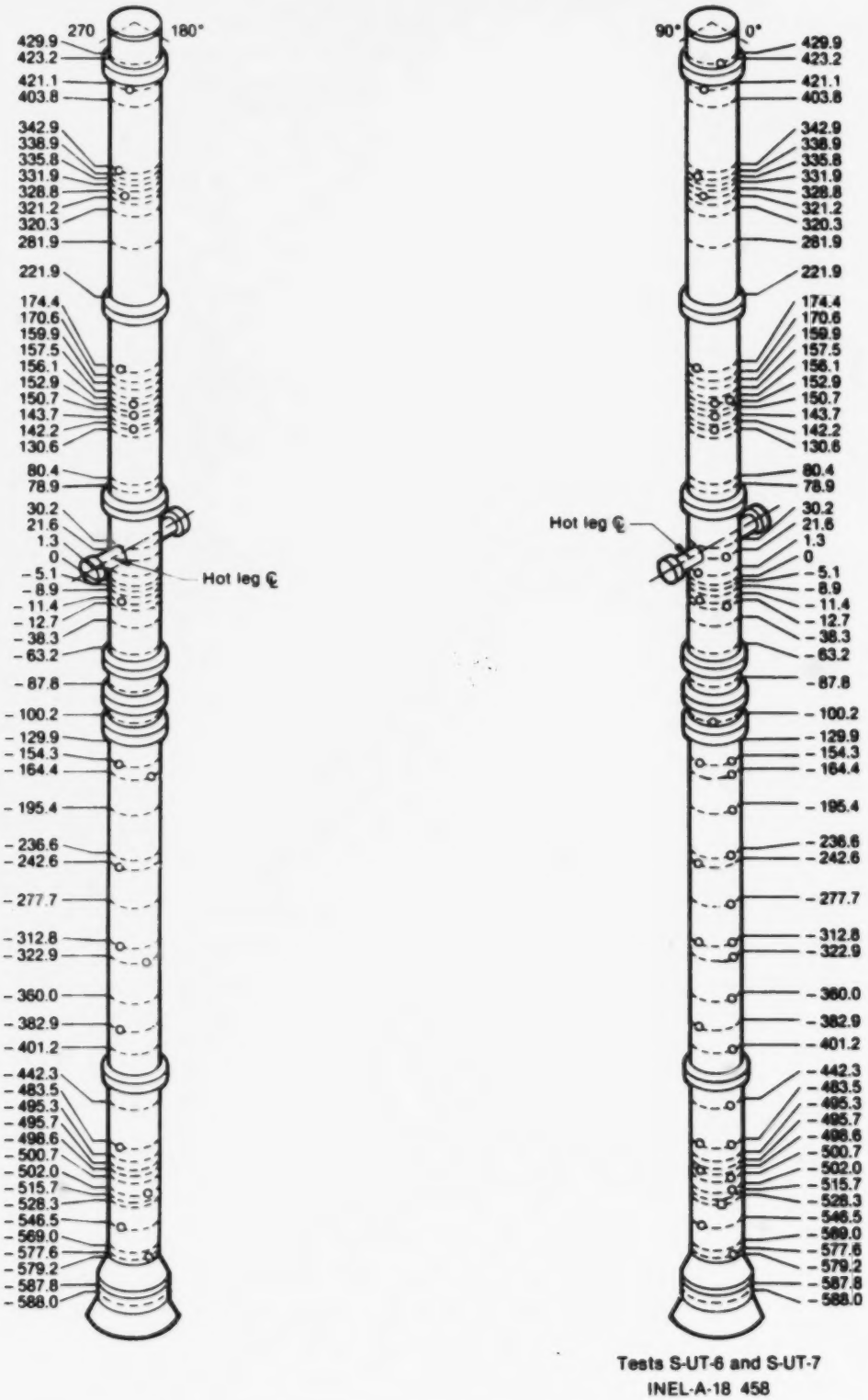

Figure 5. Semiscale Mod-2A pressure vessel—isometric showing penetrations.

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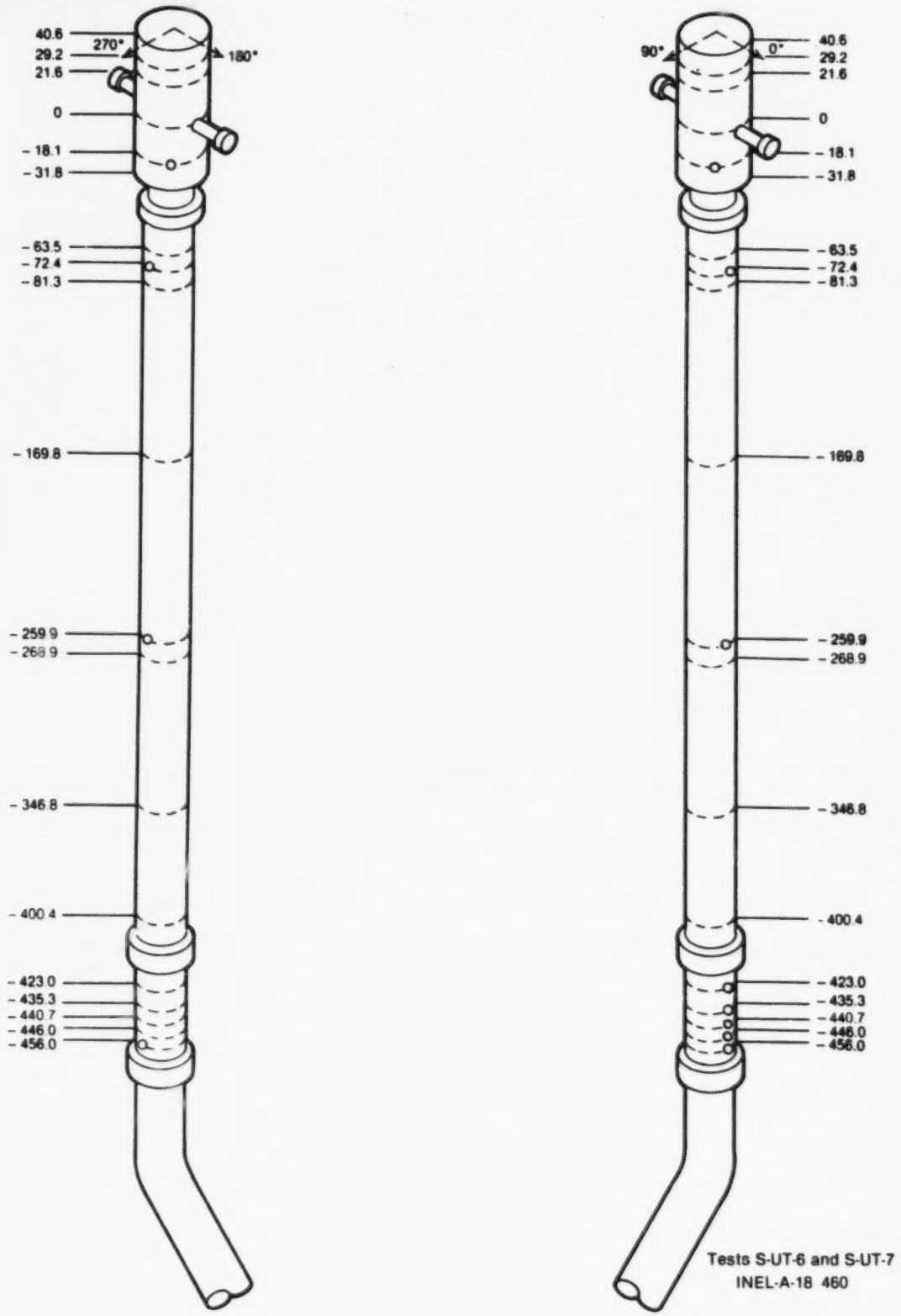

Figure 6. Semiscale Mod-2A downcomer—isometric showing penetrations.

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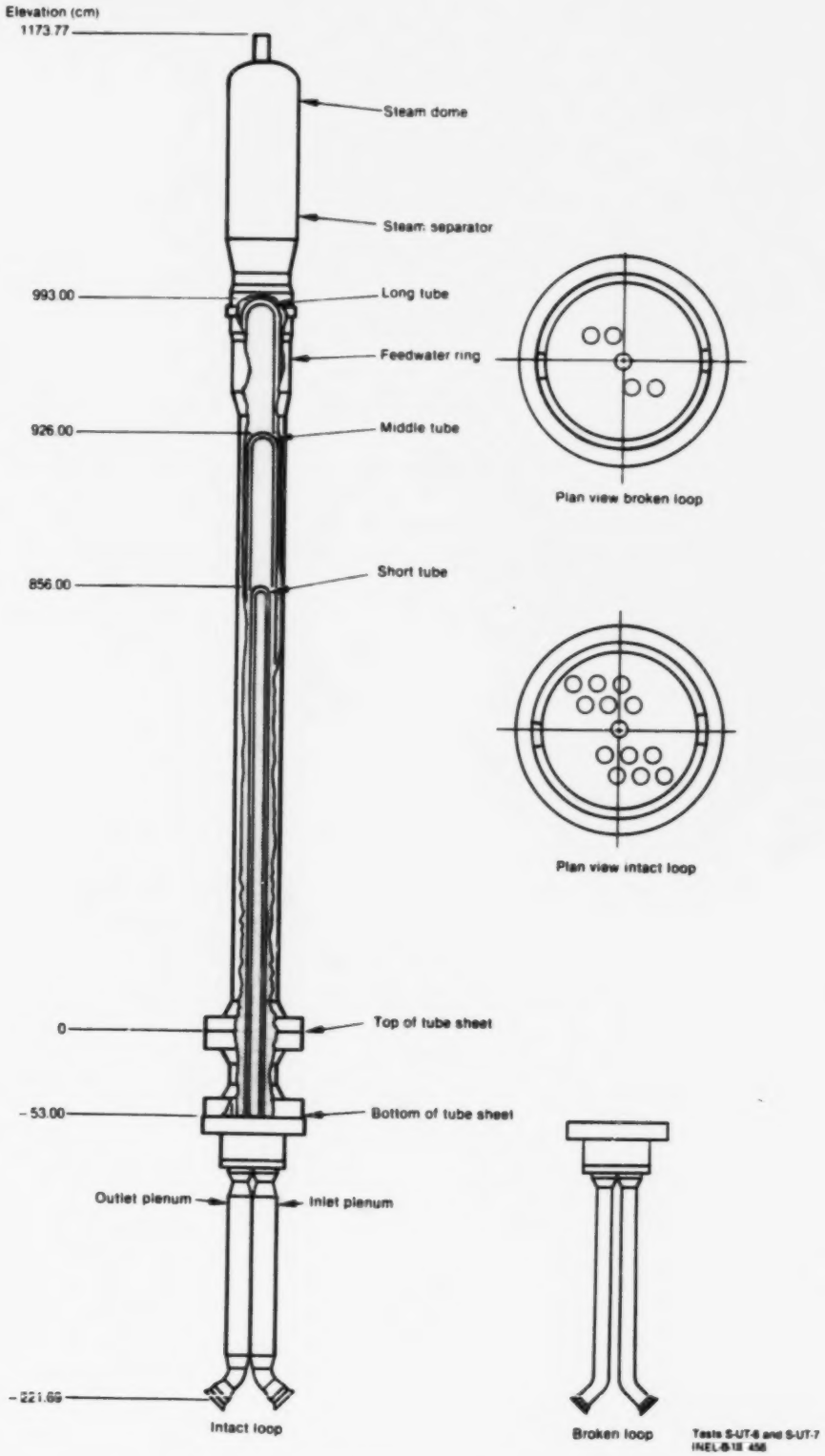

Figure 7. Semiscale Mod-2A steam generator—cross section.

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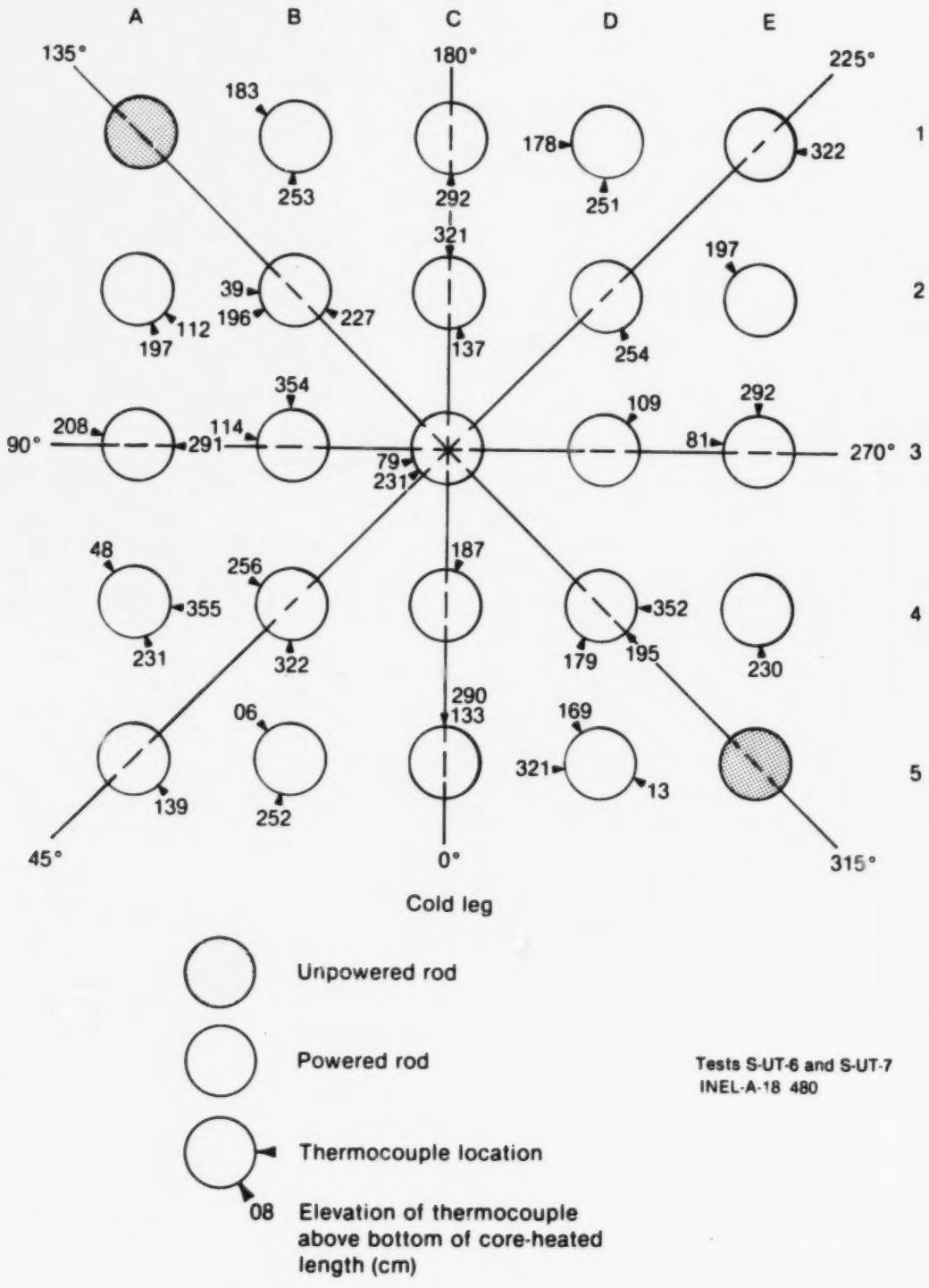

Figure 8. Semiscale Mod-2A heated core plan view.

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Table 4. Data presentation for Semiscale Mod-2A Tests S-UT-6 and S-UT-7

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
FLUID TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise.				
		0 to 1533 K	0 to 820 K		
Intact Loop					
TFI*1	Hot leg, Spool 1, 50 cm from vessel center.			9	
TFI*11	Cold leg, Spool 11, 438 cm from downcomer center.			10	
TFI*17	Cold leg, Spool 17, 60 cm from downcomer center.			11	
		0 to 1533 K	0 to 820 K		
Broken Loop					
TFB*20	Hot leg, Spool 20, 84 cm from vessel center, 25 cm downstream of hot leg injection port.			12	
TFB*37	Cold leg, Spool 37, 337 cm from downcomer center.			13	
TFB*40	Cold leg, Spool 40, 213 cm from downcomer center.			14	
TFB*41	Cold leg, Spool 41, 150 cm from downcomer center.			15	
TFB*45	Cold leg, Spool 45, 78 cm from downcomer center.			16	
		0 to 1533 K	0 to 820 K		
Vessel					
Vessel Downcomer					
TFV*DC-84	In downcomer extension, 84 cm below cold leg centerline.			17	
TFV*DC-270	In downcomer extension, 270 cm below cold leg centerline.			18	
TFV*DC-435	In downcomer instrument spool, 435 cm below cold leg centerline.			19	
Vessel Lower Plenum					
TFV*LP-577	In vessel lower plenum, 577 cm below cold leg centerline.	0 to 1533 K	0 to 820 K	20	
Vessel Upper Plenum		0 to 1533 K	0 to 820 K		
TFV*UPM-13	In vessel upper plenum, 13 cm below cold leg centerline at 180°.			21	
Vessel Upper Head		0 to 1533 K	0 to 820 K		
TFV+UHQ402	In vessel upper head, 402 cm above cold leg centerline at 225°.			22	
TFV+UHQ373	In vessel upper head, 373 cm above cold leg centerline at 225°.			23	
TFV+UHQ343	In vessel upper head 343 cm above cold leg centerline at 325°.			24	
TFV+UHQ282	In vessel upper head, 282 cm above cold leg centerline at 225°.			25	
TFV+UHQ252	In vessel upper head, 252 cm above cold leg centerline at 225°.			26	
TFV+UHQ221	In vessel upper head, 221 cm above cold leg centerline at 225°.			27	
TFV+UHQ180	In vessel upper head, 180 cm above cold leg centerline at 225°.				Detector Failed
TFV*BY	In bypass line connecting upper head to downcomer.			28	Failed S-UT-6
		0 to 1533 K	0 to 820 K		
Vessel Guide Tube					
TFV*GT+304	In vessel guide tube, 304 cm above cold leg centerline at 315°.	0 to 1533 K	0 to 820 K	29	
Vessel Support Column					
TFV*SCD114	In vessel support tube, 114 cm above cold leg centerline at 45°.			30	
TFV*SCQ114	In vessel support tube, 114 cm above cold leg centerline at 225°.			31	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	Data Acquisition Range[a] System	Figure[a]	Measurement Comments[b]
Vessel Thermal Shield		0 to 1533 K	0 to 820 K		
TFV*TSG221	In vessel thermal shield, 221 cm above cold leg centerline at 90°.			32	
Core Grid Spacers		0 to 1533 K	0 to 1580 K		
Grid Spacer 1	490 cm below cold leg centerline, 6 cm above bottom of heated length.				
TFV*D4+6	Thermocouple in space defined by Columns D and E, Rows 4 and 5.			33	
Grid Spacer 4	370 cm below cold leg centerline, 126 cm above bottom of heated length.				
TFV*B3+126	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			34	
Grid Spacer 5	330 cm below cold leg centerline, 166 cm above bottom of heated length.				
TFV*B3+166	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			35	
Grid Spacer 6	290 cm below cold leg centerline, 206 cm above bottom of heated length.				
TFV*B3+206	Thermocouple in space defined by Columns B and C, Rows 3 and 4.			36	
Grid Spacer 8	210 cm below cold leg centerline, 286 cm above bottom of heated length.				
TFV*A4+286	Thermocouple in space defined by Columns A and B, Rows 4 and 5.			37	
Grid Spacer 9	170 cm below cold leg centerline, 326 cm above bottom of heated length.				
TFV*A4+326	Thermocouple in space defined by Columns A and B, Rows 4 and 5.			38	
Grid Spacer 10	130 cm below cold leg centerline, 366 cm above bottom of heated length.				
TFV*A4+366	Thermocouple in space defined by Columns A and B, Rows 4 and 5.			39	
ECC System		0 to 1533 K	0 to 820 K		
TFCI*VUH	In ECC line, at vessel upper head.			40	
TFCI*I17	In ECC line, at intact loop spool piece 17.			41	
TFCI*B40	In ECC line, at broken loop spool piece 40.			42	
Steam Generator		0 to 1533 K	0 to 820 K		
Intact Loop					
TFIP+LH30	Primary side, 30 cm above top of tube sheet, on long tube, hot (inlet) side.			43	
TFIP+LC84	Primary side, 84 cm above top of tube sheet, on long tube, cold (outlet) side.				Detector Failed
TFIP+SC30	Primary side, 30 cm above top of tube sheet, on short tube cold (outlet) side				Detector Failed
TFIP+LH922	Primary side, 922 cm above top of tube sheet, on long tube, hot (inlet) side.			44	
Broken Loop		0 to 1533	0 to 820 K		
TFBP+SH452	Primary side, 452 cm above top of tube sheet, on short tube, hot (inlet) side.			45	
TFBP+LC785	Primary side, 785 cm above top of tube sheet, on long tube, cold (outlet) side.			46	
TFBP+LH922	Primary side, 922 cm above top of tube sheet, on long tube, hot (inlet) side.			47	
Secondary Side		0 to 1533	0 to 820 K		
TFIS*D+457	Secondary side, downcomer 457 cm above top of tube sheet.			48	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	Data Acquisition Range[a] System	Figure[a]	Measurement Comments[b]
Secondary Side (continued)					
TFIS*LH30	Secondary side, 30 cm above top of tube sheet, on long tube, hot (inlet) side.			49	
TFIS*LC84	Secondary side, 84 cm above top of tube sheet, on long tube, cold (outlet) side.			50	
TFIS*LH152	Secondary side, 152 cm above top of tube sheet, on long tube, hot (inlet) side.			51	
TFIS*LH922	Secondary side, 922 cm above top of tube sheet on long tube, hot (inlet) side.			52	
TFBS*D*457	Secondary side, downcomer 457 cm above top of tube sheet.			53	S-UT-7 only
TFBS*LH30	Secondary side, 30 cm above top of tube sheet, on long tube, hot (inlet) side.			54	S-UT-6 only
TFBS*LH61	Secondary side, 61 cm above top of tube sheet, on long tube, hot (inlet) side.				Detector failed
TFBS*SH452	Secondary side, 452 cm above top of tube sheet, on short tube, hot (inlet) side.			55	
TFBS*LC785	Secondary side, 785 cm above top of tube sheet, on long tube, cold (outlet) side.			56	
TFBS*LH922	Secondary side, 922 cm above top of tube sheet, on long tube, hot (inlet) side.			57	
Secondary Coolant		0 to 1533 K	0 to 830 K		
TFSC*8(I)	Intact loop steam generator, secondary coolant system feedwater.			58	
TFSC*1(B)	Broken loop steam generator, secondary coolant system feedwater.			59	
TFSC*10(I)	Intact loop steam generator, secondary coolant system steam dome exit.			60	
TFSC*13(B)	Broken loop steam generator, secondary coolant system steam dome exit.			61	
Pressurizer		0 to 1533 K	0 to 830 K		
TFPRZ+132	In top of pressurizer 132 cm, above pressurizer exit.			62	
TFI*56-73	In surge line, 73 cm below pressurizer exit.			63	
MATERIAL TEMPERATURE	Chromel-Alumel thermocouples unless specified otherwise.				
Intact Loop		0 to 1533 K	0 to 820 K		
THEP*1	Hot leg, Spool 1, on heater band outside surface.			64	
THI*EP*1	Hot leg, Spool 1, on pipe surface near heater band.			65	
THEP*4A	Hot leg, Spool 4, on heater band outside surface.			66	
THI*EP*4	Hot leg, Spool 4, embedded in pipe under heater band.			67	S-UT-7 only.
THEP*8*N	Cold leg, Spool 8, on heater band outside surface, near center of spool piece 8.			68	
THEP*8*T	Cold leg, Spool 8, on heater band outside surface, at top of spool piece 8.			69	
THI*EP*8	Cold leg, Spool 8, on pipe surface near heater band.			70	
THEP*14	Cold leg Spool 14, on heater band outside surface.			71	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
Intact Loop (continued)					
TMI*EH*14B	Cold leg, Spool 14, on pipe surface between heater band.			72	
TMEH*17	Cold leg, Spool 17, on heater band outside surface.			73	
Broken Loop		0 to 1533 K	0 to 820 K		
TMEH*20	Hot leg, Spool 20, on heater band outside surface.			74	
TMEH*21A	Hot leg, Spool 21, on heater band outside surface, near center of spool 21.			75	
TMEH*21B	Hot leg, Spool 21, on heater band outside surface, near downstream end of Spool 21.			76	
TMB*EH*21A	Hot leg, Spool 21, Embedded in pipe under heater band, near center of Spool 21.			77	Failed S-UT-6
TMEH*27*T	Cold leg, Spool 27, on heater band outside surface, at top of Spool 27.			78	
TMEH*27*B	Cold leg, Spool 27, on heater band outside surface, near bottom of Spool 27.			79	
TMB*EH*29M	Cold leg, Spool 29, embedded in pipe under heater band, near center of Spool 29.			80	
TMEH*37	Cold leg, Spool 37, on heater band outside surface.			81	
TMEH*40	Cold leg, Spool 40, on heater band outside surface.			82	
TMEH*45	Cold leg, Spool 45, on heater band outside surface.			83	
Vessel Downcomer					
Vessel		0 to 1533 K	0 to 820 K		
TMV+FPF343	In vessel on upper head filler piece, 343 cm above cold leg centerline at 75°.			84	
TMV+FPF221	In vessel on upper head filler piece, 221 cm above cold leg centerline at 75°.			85	
TMV+TSQ221	In vessel on thermal shield, 221 cm above cold leg centerline at 225°.			86	
Steam Generator		0 to 1533 K	0 to 820 K		
Intact Loop					
TMIG+LW30	Long tube hot leg side 30 cm above top of tube sheet on OD of tube.			87	Failed S-UT-6
TMIG+SC452	Short tube cold leg side 452 cm above top of tube sheet on OD of tube.			88	
Broken Loop		0 to 1533 K	0 to 820 K		
TMBG+SC30	Short tube cold leg side, 30 cm above top of tube sheet on OD of tube.			89	S-UT-6 only.
CORE HEATER CLADDING TEMPERATURE					
High Power Heaters		0 to 1533 K	0 to 1580 K		
THV*B2+39 THV*B2+196 THV*B2+227	Heater at Column B, Row 2. Thermocouples 39 cm (90°) 196 cm (50°), 227 cm (308°) above bottom of heated length.			90 91 92	
THV*B3+114 THV*B3+354	Heater at Column B, Row 3. Thermocouples 114 cm (97°) and 354 cm (180°) above bottom of heated length.			93 94	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	Data Acquisition Range[a] System	Figure[a]	Measurement Comments[b]
High Power Heaters (continued)					
THV*B4+256 THV*B4+322	Heater at Column B, Row 4. Thermocouples 256 cm (131°) and 322 cm (0°) above bottom of heated length.			95 96	
THV*C2+137 THV*C2+321	Heater at Column C, Row 2. Thermocouples 137 cm (351°) and 321 cm (180°) above bottom of heated length.			97 98	
THV*C3+79 THV*C3+231	Heater at Column C, Row 3. Thermocouples 79 cm (75°) and 231 cm (54°) above bottom of heated length.			99 100	
THV*C4+187	Heater at Column C, Row 4. Thermocouple 187 cm (182°) above bottom of heated length.			101	
THV*D2+254	Heater at Column D, Row 2. Thermocouple 254 cm (351°) above bottom of heated length.			102	
THV*D3+109	Heater at Column D, Row 3. Thermocouple 109 cm (217°) above bottom of heated length.			103	
THV*D4+179 THV*D4+195 THV*D4+352	Heater at Column D, Row 4. Thermocouple 179 cm (26°), 195 cm (315°), and 352 cm (270°) above bottom of heated length.			104 105 106	
Lower Power Heaters		0 to 1533 K	0 to 1580 K		
THV*A2+112 THV*A2+197	Heater at Column A, Row 2. Thermocouples 112 cm (298°), and 197 cm (320°) above bottom of heated length.			107 108	
THV*A3+208 THV*A3+291	Heater at Column A, Row 3. Thermocouples 208 cm (121°) and 291 cm (270°) above bottom of heated length.			109 110	
THV*A4+48 THV*A4+231 THV*A4+355	Heater at Column A, Row 4. Thermocouples 48 cm (149°), 231 cm (339°), and 355 cm (270°) above bottom of heated length.			111 112 113	
THV*A5+139	Heater at Column A, Row 5. Thermocouple 139 cm (317°) above bottom of heated length.			114	
THV*B1+183 THV*B1+253	Heater at Column B, Row 1. Thermocouples 183 cm (131°) above and 253 cm (1°) above bottom of heated length.			115 116	
THV*B5+6 THV*B5+252	Heater at Column B, Row 5. Thermocouples 6 cm (155°) and 252 cm (22°) above bottom of heated length.			117 118	
THV*C1+292	Heater at Column C, Row 1. Thermocouple 292 cm (0°) above bottom of heated length.			119	
THV*C5+133 THV*C5+290	Heater at Column C, Row 5. Thermocouples 133 cm (180°) and 290 cm (180°) above bottom of heated length.			120 121	
THV*D1+178 THV*D1+251	Heater at Column D, Row 1. Thermocouples 178 cm (80°) and 251 cm (3°) above bottom of heated length.			122 123	
THV*D5+13 THV*D5+169 THV*D5+321	Heater at Column D, Row 5. Thermocouple 13 cm (291°), 169 cm (140°) and 321 cm (90°) above bottom of heated length.			124 125 126	
THV*E1+322	Heater at Column E, Row 1. Thermocouple 322 cm (270°) above bottom of heated length.			127	
THV*E2+197	Heater at Column E, Row 2. Thermocouple 197 cm (135°) above bottom of heated length.			128	
THV*E3+81 THV*E3+292	Heater at Column E, Row 3. Thermocouples 81 cm (94°) and 292 cm (180°) above bottom of heated length.			129 130	
THV*E4+230	Heater at Column E, Row 4. Thermocouple 230 cm (355°) above bottom of heated length.			131	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	Data Acquisition Range[a] System	Figure[a]	Measurement Comments[b]
PRESSURE					
Intact Loop					
PI*1	Hot leg, Spool 1, 60 cm from vessel center.	0 to 17.237 MPa	0 to 21.08 MPa	132	
PI*16	Cold leg, Spool 16, 144 cm from downcomer center.	0 to 17.237 MPa	0 to 19.97 MPa	133	
PI*17(L)	Cold leg, Spool 17, 60 cm from downcomer center (low range).	0 to 3.447 MPa	0 to 3.45 MPa	134	
Broken Loop					
PB*20	Hot leg, Spool 20, 80 cm from vessel center.	0 to 17.237 MPa	0 to 21.04 MPa	135	
PB*41	Cold leg, Spool 41, 163 cm from downcomer center.	0 to 17.237 MPa	0 to 21.78 MPa	136	
PB*45	Cold leg, Spool 45, 90 cm from downcomer center.	0 to 17.237 MPa	0 to 20.71 MPa	137	
Vessel					
PV*DC-435	In downcomer, 435 cm below cold leg centerline.	0 to 17.237 MPa	0 to 20.83 MPa	138	
PV*LP-442	In vessel lower plenum, 442 cm below cold leg centerline.	0 to 17.237 MPa	0 to 20.27 MPa	139	
PV*UP-13	In vessel hot leg extension, 13 cm below cold leg centerline (tee off DP tap).	0 to 17.237 MPa	0 to 21.54 MPa	140	
ECC System					
PCI*1T+263	In accumulator for upper head injection.	0 to 17.237 MPa	0 to 20.66 MPa	141	S-UT-7 only.
PCI*2T+203 142	In accumulator for broken loop.	0 to 6.895 MPa	0 to 8.24 MPa	142	
PCI*3T+277	In accumulator for intact loop.	0 to 6.895 MPa	0 to 8.24 MPa	143	
Steam Generator					
Intact Loop					
PSC*10(I)	Intact loop steam generator Secondary side, steam dome exit.	0 to 6.895 MPa	0 to 8.548 MPa	144	
Broken Loop					
PSC*13(B)	Broken loop steam generator. Secondary side steam dome exit.	0 to 6.895 MPa	0 to 7.839 MPa	145	
Pressurizer					
PPRZ+158	Pressurizer steam dome 158 cm above pressurizer exit.	0 to 17.237 MPa	0 to 21.96 MPa	146	
DIFFERENTIAL PRESSURE	Elevation difference between transducer taps is zero unless specified otherwise.				
Intact Loop					
D-V13A*I1	From vessel lower section of upper plenum, 13 cm below cold leg centerline to hot leg, Spool 1, Tap A, 60 cm from vessel center. Lower upper plenum tap is 35 cm below Spool 1 tap.	±254 cm water	±33.78 kPa	147	
DPI*1*6	Hot leg, Spool 1, 60 cm from vessel center to hot leg, Spool 6, 271 cm from vessel center.	±254 cm water	±34.10 kPa	148	
DPI*6-IG55	Hot leg, Spool 6, 271 cm from vessel center to steam generator inlet plenum, 55 cm below top of tube sheet, 436 cm from vessel center. Spool 6, tap is 128 cm below the inlet plenum tap.	±254 cm water	±33.43 kPa		Detector failed
DIG-55E55X	Hot leg, inlet plenum, to cold leg outlet plenum across intact loop steam generator, primary side.	±689 kPa	±691.5 kPa	149	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
Intact Loop (continued)					
DP*IG-55*7	Steam generator outlet plenum, 55 cm below top of tube sheet, 1119 cm from downcomer center to cold leg, Spool 7, 927 cm from downcomer center. Spool is 175 cm below outleg plenum tap.	±254 cm water	±33.2 kPa	150	
DPI*7*9	Cold leg, Spool 7, 927 cm from downcomer center to cold leg, Spool 9, 663 cm from downcomer center. Spool 7 tap is 136 cm above Spool 9 tap.	±254 cm water	±33.24 kPa	151	
DPI*9*13	Cold leg, Spool 9, 663 cm from downcomer center to cold leg Spool 13, 332 cm from downcomer center. Spool 9 tap is 257 cm below Spool 13 tap.	±254 cm water	±33.73 kPa	152	
DPI*13*15	Cold leg, Spool 13, 332 cm from downcomer center, across primary pump to cold leg, Spool 15, 175 cm from downcomer center. Spool 13 tap is 25 cm below Spool 15 tap.	±689 kPa	±688 kPa	153	
DPI*15*17	Cold leg, Spool 15, 175 cm from downcomer center, across cold leg injection port to cold leg, Spool 17, 60 cm from downcomer center.	±254 cm water	±33.44 kPa	154	
D*117*VD29	Cold leg, Spool 17, 60 cm from downcomer center, to downcomer inlet annulus, 29 cm above cold leg centerline. Spool 17 tap is 30 cm below downcomer inlet annulus tap.	±127 cm water	±16.97 kPa	155	
Broken Loop					
D-V13M*20B	In vessel from lower section of upper plenum, 13 cm below cold leg centerline at 180 , to hot leg Spool 20, Tap B, 22 cm above cold leg centerline 84 cm from vessel center. 13 M tap is 35 cm below Spool 20 tap.	±254 cm water	±34.51 kPa	156	
DPB*20B*21	Hot leg, Spool 20, Tap B, 84 cm from vessel center to hot leg, Spool 21, 220 cm from vessel center.	±127 cm water	±19.30 kPa	157	
DPB*21BG55	Hot leg, Spool 21, 220 cm from vessel center to hot leg, steam generator inlet plenum 55 cm below top of tube sheet, 427 cm from vessel centerline. Spool 21, tap is 185 cm below inlet plenum tap.	±74.48 kPa	±99.02 kPa	158	
DBG-55E55X	Hot leg, inlet plenum, 427 cm from vessel center across primary side tubes to cold leg, outlet plenum, 1079 cm from downcomer center.	±345 kPa	±343 kPa	159	
D*BG-55*27	Steam generator, outlet plenum, 55 cm below top of tube sheet, 1072 cm from downcomer center, to cold leg Spool 27, 872 cm from downcomer center, Spool 27, is 191 cm below, outleg plenum -55 tap.	±254 cm water	±33.63 kPa	160	
DPB*27*28	Cold leg, Spool 27, 872 cm from downcomer center to cold leg Spool 28 565 cm from downcomer center. Spool 27 tap is 304 cm above Spool 28 tap.	±762 cm water	±100.6 kPa	161	
DPB*27*37B	Cold leg Spool 27, 872 cm from downcomer center to cold leg Spool 37, Tap B, 330 cm from downcomer center elevation difference between taps is 83 cm.	±762 cm water	±102.4 kPa	162	
DPB*28*37B	Cold leg, Spool 28, 565 cm from downcomer center to cold leg Spool 37, Tap B, 487 cm from downcomer center. Spool 28 tap is 233 cm below Spool 37, Tap B.	±762 cm water	±101.3 kPa	163	
DB*37B*40B	Cold leg, Spool 37, Tap B, 487 cm from downcomer center across broken loop pump to cold leg, Spool 40, Tap B, 202 cm from downcomer center. Spool 37 Tap B is 67 cm below Spool 40 Tap B.	±690 kPa	±689 kPa	164	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a]		Figure[a]	Measurement Comments[b]
		Detector	System		
Broken Loop (continued)					
DB*40B*41U	Cold leg, Spool 40, Tap B, pump discharge 202 cm from downcomer center leg, Spool 41, Tap U, 145 cm from downcomer center.	±762 cm water	±100.5 kPa	165	
DPB*41U*A	Cold leg Spool 41, Tap U, 145 cm from downcomer center to cold leg Spool 41, Tap A, 191 cm from downcomer center.	±10,343 kPa	±13,860 kPa	166	
DPB*41U*45	Cold leg, Spool 41, Tap U, 145 cm from downcomer center to cold leg, Spool 45, 89 cm from downcomer center.	±254 cm water	±33.26 kPa	167	
D*B45*VD29	Cold leg, Spool 45, 89 cm from downcomer center to downcomer inlet annulus, 29 cm above cold leg centerline. Spool 45 tap is 30 cm below downcomer inlet annulus tap.	±127 cm water	±16.64 kPa	168	
Vessel					
DV*29-13A	Downcomer inlet annulus, 29 cm above cold leg centerline to vessel upper plenum, 13 cm below cold leg centerline at 0 . Elevation difference between taps is 42 cm.	±345 kPa	±341 kPa	169	
LIQUID LEVEL					
Vessel					
LVD*29-578	Downcomer inlet annulus, 29 cm above cold leg centerline to vessel lower head, 578 cm below cold leg centerline. Elevation difference between taps is 607 cm.	±762 cm water	±100.6 kPa	170	
LVD*29-170	Downcomer inlet annulus, 29 cm above cold leg centerline to downcomer extension, 170 cm below cold leg centerline. Elevation difference between taps is 199 cm.	±762 cm water	±100.1 kPa	171	
LVD170-578	Downcomer extension, 170 cm below cold leg centerline to downcomer instrumented spool piece, 578 cm below cold leg centerline. Elevation difference between taps is 408 cm.	±762 cm water	±114.4 kPa	172	
LV-578-13M	Vessel lower plenum, 578 cm below cold leg centerline to lower section of upper plenum, 13 cm below cold leg centerline at 180 . Elevation difference between taps is 565 cm.	±124.5 kPa	±166.3 kPa	173	
LV-578-501	Vessel lower plenum, 578 cm below cold leg centerline to lower plenum, 501 cm below cold leg centerline. Elevation difference between taps is 77 cm.	± 12.41 kPa	±17.04 kPa	174	
LV-501-105	Vessel lower core region, 501 cm below cold leg centerline to heater rod ground hub, 105 cm below cold leg centerline. Elevation difference between taps is 396 cm.	±124.5 kPa	±172.8 kPa	175	
LV-501-278	Vessel lower core region, 501 cm below cold leg centerline to lower core region, 278 cm below cold leg centerline. Elevation difference between taps is 223 cm.	±254 cm water	±33.9 kPa	176	
LV-278-154	Vessel mid-core region, 278 cm below cold leg centerline to upper core region 154 cm below cold leg centerline. Elevation difference between taps is 124 cm.	±254 cm water	±34.21 kPa	177	
LV-154+160	Vessel upper core region 154 cm below cold leg centerline to vessel lower head 160 cm above cold leg centerline. Elevation difference between taps is 314 cm.	±762 cm water	±100.6 kPa	178	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
LIQUID LEVEL					
Vessel (continued)					
LV-154-105	Vessel upper core region 154 cm below cold leg centerline to heater rod ground hub, 105 cm below cold leg centerline. Elevation difference between taps is 49 cm.	±254 cm water	±33.46 kPa	179	
LV-105-13M	Heater rod ground hub, 105 cm below cold leg centerline to lower section of upper plenum, 13 cm below cold leg centerline at 180 . Elevation difference between taps is 92 cm.	±254 cm water	±33.45 kPa	180	
LV-13A+421	Vessel upper head region, 421 cm above cold leg centerline to vessel upper plenum, 13 cm below cold leg centerline at 0 . Elevation difference between taps is 434 cm.	±762 cm water	±101.4 kPa	181	
LV+160+421	Vessel upper head, 160 cm above cold leg centerline to vessel upper head 421 cm above cold leg centerline. Elevation difference between taps is 261 cm.	±762 cm water	±105.3 kPa	182	
ECC System					
LC*A1+263	Top to bottom of accumulator for upper head injection. Elevation difference between Taps is 263 cm.	±68.9 kPa	±91.14 kPa		Detector failed.
LC*A2+203	Top to bottom of accumulator for broken loop. Elevation difference between taps is 203 cm.	±762 cm water	±104.3 kPa	183	
LC*A3+277	Top to bottom of accumulator for intact loop. Elevation difference between taps is 277 cm.	±762 cm water	±99.78 kPa	184	
Steam Generator					
Liquid Level					
Intact Loop					
LIP966-55E	Hot leg, Inlet plenum 55 cm below top of tube sheet to primary side of steam generator 966 cm from top of tube sheet. Elevation difference between taps is 1021 cm.	±1,270 cm water	±174.2 kPa	185	
LIP966-55X	Primary side of steam generator 966 cm from top of tube sheet to cold leg, outlet plenum 55 cm below top of tube sheet. Elevation difference between taps is 1021 cm.	±1,270 cm water	±175.4 kPa	186	
LID761+304	Secondary side of steam generator downcomer, 761 cm to 304 cm above top of tube sheet. Elevation difference between taps is 457 cm.	±762 cm water	±105.7 kPa	187	S-UT-6 only.
LIS1112+90	Secondary side of steam generator 1112 cm to 90 cm above top of tube sheet. Elevation difference between Taps 1022 cm.	±1,270 cm water	±167.9 kPa	188	S-UT-6 only.
LIS460+966	Secondary side of steam generator 460 cm to 966 cm above top of tube sheet. Elevation difference between taps is 506 cm.	±1,270 cm water	±168.2 kPa	189	S-UT-6 only.
LIS90+460	Secondary side of steam generator 90 cm to 460 cm above top of tube sheet. Elevation difference between taps is 370 cm.	±762 cm water	±99.79 kPa	190	S-UT-6 only.
Broken Loop					
LBP835-55E	Primary side of steam generator 835 cm above top of tube sheet to hot leg, inlet plenum 55 cm below top of tube sheet elevation difference between taps is 890 cm.	±762 kPa	±171.7 kPa	191	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
Broken Loop (continued)					
LBP835-55X	Primary side of steam generator 835 cm above top of tube sheet to cold leg, Spool 26. Elevation difference between taps is 890 cm.	±1,270 cm water	±164.5 kPa	192	
LBD761+304	Secondary side of steam generator, downcomer, 761 cm to 304 cm above top of tube sheet. Elevation difference between taps is 457 cm.	±762 cm water	±105.7 kPa	193	S-UT-7 only.
LBS1112+90	Secondary side of steam generator 1112 cm to 90 cm above top of tube sheet. Elevation difference between taps is 1022 cm.	762 cm water	±171.7 kPa	194	
LBS460+966	Secondary side of steam generator 460 cm to 966 cm above top of tube sheet. Elevation difference between taps is 506 cm.	±1,270 cm water	±168.2 kPa	195	S-UT-7 only.
LBS90+460	Secondary side of steam generator 90 cm to 460 cm above top of tube sheet. Elevation difference between taps is 370 cm.	±762 cm water	±99.8 kPa	196	S-UT-7 only.
DPSC*FE8	Across orifice plate in feedwater line to steam generator for intact loop.	±1,270 cm water	±167.4 kPa	197	Failed S-UT-7
DPSC*FE10	Across venturi tube in discharge line from steam generator for intact loop.	±2,032 cm water	±266.2kPa	198	
DPSC*FE1	Across orifice plate in feedwater line to steam generator for broken loop.	±2,032 cm water	±266.2 kPa	199	
DPSC*FE13	Across venturi tube in discharge line from steam generator for broken loop.	±1,270 cm water	±168.5 kPa	200	
Pressurizer					
DP*PRZ*I4	In surge line between pressurizer and intact loop, Spool 4. Elevation difference between taps is 157 cm.	±3447 kPa	±3457 kPa	201	
LPRZ25+158	Liquid level for pressurizer. Elevation difference between taps is 133 cm.	±127 cm water	±16.9 kPa	202	
VOLUMETRIC FLOW RATE	Turbine flowmeter, bidirectional.				
Intact Loop	3-in. Schedule 160 pipe.				
QI*1	Hot leg, Spool 1, 38 cm from vessel center.	±1.26 to ±12.6 L/s	±13 L/s	203	
QI*11	Cold leg, Spool 11, 429 cm from downcomer center.	±1.26 to ±12.6 L/s	±13 L/s	204	
QI*16	Cold leg, Spool 16, 145 cm from downcomer center.	±5.05 to ±50.5 L/s	±13 L/s	205	
QI*17	Cold leg, Spool 17, 38 cm from downcomer center.	±1.26 to ±12.6 L/s	±13 L/s	206	
Broken Loop	1-1/2 in. Schedule 160 pipe.				
QB20	Hot leg, Spool 20, 100 cm from vessel center.	±1.26 to ±12.6 L/s	±6 L/s	207	Failed S-UT-6.
QB*37	Cold leg, Spool 37, 305 cm from downcomer center.	±1.26 to ±12.6 L/s	±6 L/s	208	
QB*40	Cold leg, Spool 40, 186 cm from downcomer center.	±1.26 to ±12.6 L/s	±6 L/s	209	
QB*45	Cold leg, Spool 45, 110 cm from downcomer center.	±0.63 to ±6.31 L/s	±6 L/s	210	Failed S-UT-6.
Vessel					
QV*DC-423	In downcomer 423 cm below cold leg centerline.	±1.35 to ±13.5 L/s	±22 L/s		Detector Failed
QV*UP+1	Core exit, 1 cm above cold leg centerline.	±1.35 to 13.5 L/s	±19 L/s	211	
QV*GT+321	In vessel upper head 321 cm above hot leg centerline.	±0.075 to ±0.750 L/s	±1.0 L/s	212	Unidirectional

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
Vessel (continued)					
QV*SCD+144	In vessel upper plenum support column,144 cm above cold leg centerline, at 45°.	±0.0175 to ±0.175 L/s	±0.250 L/s	213	Unidirectional
QV*SCQ+144	In vessel upper plenum support column 144 cm above cold leg centerline, at 225°.	±0.022 to ±0.220 L/s	±0.250 L/s	214	Unidirectional
QV*BY	In upper head heatup bypass line.	±0.49 to ±4.9 L/s	±3.0 L/s	215	
ECC System					
Intact Loop					
QCI*1(1T)	In line leading from upper head injection accumulator, 1-in. line.	±0.32 to ±3.15 L/s	±1.0 L/s	216	S-UT-7 only
QCI*5(2T)	In line lead in from broken loop accumulator, 3/4-in. line.	±0.126 to ±1.26 L/s	±1.0 L/s	217	
QCI*27(3T)	In line leading from intact loop accumulator; 1-in. line.	±0.30 to ±3.15 L/s	±3.20 L/s		Detector failed
QCI*13(HI)	In line leading from HPIS pump for intact loop, 1/2-in. line.	±0.032 to ±0.315 L/s	±0.320 L/s	218	
QCI*14(HB)	In line leading from HPIS pump for broken loop, 1/2-in. line.	±0.060 to ±0.63 L/s	±0.200 L/s	219	
Pressurizer					
QI*56-30	In pressurizer surge line 30 cm below pressurizer exit.	±0.113 to ±1.130 L/s	±1.20 L/s	220	
MOMENTUM FLUX	Drag-screen, bidirectional.				
Intact Loop					
FI*1	Hot leg, Spool 1, 38 cm from vessel center.	±0.528 to ±10.56 N	±10.56 N	221	
FI*11	Cold leg, Spool 11, 429 cm from downcomer center.	±0.528 to ±10.57 N	±10.56 N	222	Failed S-UT-7.
FI*17	Cold leg, Spool 17, 38 cm from downcomer center.	±0.528 to ±10.56 N	±10.56 N	223	
Broken Loop					
FB*20	Hot leg, Spool 20, 104 cm from vessel center.	±0.013 to ±2.64 N	±2.641 N	224	
FB*40	Cold leg, Spool 40, 208 cm from downcomer center.	±0.013 to ±2.64 N	±2.641 N	225	Failed S-UT-7.
FB*41	Cold leg, Spool 41, 198 cm from downcomer center.	±0.25 to ±50.01 N	±4.98 N	226	Failed S-UT-6.
FB*45	Cold leg, Spool 45, 84 cm from downcomer center.	±0.013 to ±2.64 N	±2.64 N	227	
Vessel					
FV*DC-441	In downcomer, 441 cm below cold leg centerline.	±0.053 to ±10.51 N	±10.78 N	228	
FV*UP-9	In vessel lower upper plenum region, 9 cm below cold leg centerline.	±0.06 to ±12.0 N	±12.0 N	229	
FV*GT+330	Vessel guide tube, 330 cm above cold leg centerline.	±0.04 to ±0.80 N	±0.80 N	230	
FV*SCD+153	Vessel support column, 153 cm above cold leg centerline, 45°.	±0.015 to ±0.29 N	±0.29 N	231	Failed S-UT-6.

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	System	Figure[a]	Measurement Comments[b]
Vessel (continued)					
FV*SCQ*153	Vessel support column, 153 cm above cold leg centerline, 225 .	±0.015 to ±0.29 M	±0.29 M	232	
DENSITY					
Intact Loop		1.6 to	0 to 1600 kg/m^3	1600 kg/m^3	
RI*1T RI*1B RI*1C	Hot leg, Spool 1, 77 cm from vessel center. T (tangential), B (body). C is a mathematical composite of T and B.			233 234 235	
RI*16T RI*16B RI*16C	Cold leg, Spool 16, 131 cm from downcomer center. T (tangential), B (body) C is a mathematical composite of T and B.			236 237 238	
RI*17T RI*17B RI*17C	Cold leg, Spool 17, 73 cm from downcomer center. T (tangential) B (body). C is a mathematical composite of T and B.			239 240 241	
Broken Loop		1.6 to 1600	0 to 1600 kg/m^3	kg/m^3	
RB*20M RB*20B RB*20C	Hot leg, Spool 20, 64 cm from vessel center. M (middle), B (bottom). C is a mathematical composite of M and B.			242 243 244	
RB*37	Cold leg, Spool 37, 350 cm from downcomer center.			245	
RB*40M RB*40B	Cold leg, Spool 40, 223 cm from downcomer center. M (middle), B (bottom).			246 247	Trend data only Trend data only
RB*41M RB*41B RB*41C	Cold leg, Spool 41, 170 cm from downcomer center. M (middle), B (bottom). C is mathematical composite of M and B.			248 249 250	
RB*45M RB*45B	Cold leg, Spool 45, 66 cm from downcomer centerline.			251	Detector failed.
Vessel		1.6 to 1600 kg/m^3	0 to 1600 kg/m^3		
RV*DC-72	Downcomer, 72 cm below cold leg centerline. B (body).			252	
RV*DC-260	Downcomer, 260 cm below cold leg centerline. B (body).			253	
RV*DC-456	Downcomer, 456 cm below cold leg centerline. B (body).			254	
RV*LP*AB-6	6 cm below bottom of core heated length, between heater rod Columns A and B.			255	
RV*23+13	13 cm above bottom of core heated length, between heater rod Rows 2 and 3.			256	
RV*23+113	113 cm above bottom of core heated length between heater rod Rows 2 and 3.			257	
RV*AB+173	173 cm above bottom of core heated length, between heater rod Columns A and B.			258	
RV*23+183	183 cm above bottom of core heated length between heater rod Rows 2 and 3.			259	
RV*23+253	253 cm above bottom of core heated length between heater rod Rows 2 and 3.			260	
RV*AB+332	332 cm above bottom of core heated length, between heater rod Columns A and B.				Detector failed

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	Data Acquisition Range[a] System	Figure[a]	Measurement Comments[b]
Vessel (continued)					
RV*23+342	342 cm above bottom of core heated length, between heater rod Rows 2 and 3.			261	
RV*UP-11	Vessel at base of core flow instrument housing, 11 cm below cold leg centerline.			262	
RV*UH+339	Vessel at top of control rod guide tube, 339 cm above cold leg centerline.			263	
RV*UH+173	Vessel at top of core support tube, 173 cm above cold leg centerline.			264	
MASS FLOW RATE	Mass flow rate obtained by combining density (gamma attenuation technique) with volumetric flow rate (turbine flowmeter) or momentum flux (drag screen).	Range for mass flow is determined from ranges of individual detectors used in calculation.			
Intact Loop					
QI*1, RI*1C	Hot leg, Spool 1.			265 266	
FI*1, RI*1C				267 268	
QI*16, RI*16C	Cold leg, Spool 16.			269 270	
QI*17, RI*17C	Cold leg, Spool 17.			271 272	
FI*17, RI*17C				273 274	
Broken Loop					
QB*20, RB*20C FB*20, RB*20C	Hot leg, Spool 20.			275 S-UT-7 only 276 277	
QB*37, RB*37	Cold leg, Spool 37.			278 279	
FB*41, RB*41C	Cold leg, Spool 41.			280 S-UT-7 only	
QB*45, RB*45B FB*45, RB*45B	Cold leg, Spool 45.			281 282 283	
Vessel					
FV*DC-441, RV*DC-457	Vessel downcomer.			284 285	
FV*UP-9, RV*UP-11	Core instrument housing.			286 287	
QV*UP+1, RV*UP-11	Core outlet.			288 289	
QV*GT+321, RV*UH+339 FV*GT+330, RV*UH+339	Vessel upper head Vessel upper head.			290 291 292 293	
FV*SCD+153, RV*UH+173 FV*SCQ+153, RV*UH+173	Vessel upper head. Vessel upper head.			294 S-UT-7 only 295 296	
QV*SCD+144, RV*UH+173 QV*SCQ+144, RV*UH+173	Vessel upper head. Vessel upper head.			297 298 299 300	
Condensing System					
BREAK*MASS Q*BRK*FLOW	Integrated mass flow Volumetric flow thru the break			301 302	
CORE CHARACTERISTICS					
High Power Bus					
IV*HIPWBUS	Core current.	0 to 10,000 A	0 to 10,030 A	303	
EV*HIPWBUS	Core voltage.	0 to 400 V	0 to 402 V	304	
Lower Power Bus					
IV*LOPWBUS	Core current.	0 to 10,000 A	0 to 9330 A	305	
EV*LOPWBUS	Core voltage.	0 to 400 V	0 to 402 V	306	
Calculated Power					
KWH*HIC	Power for high power bus.			307	
KWH*LOC	Power for low power bus.			308	

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Table 4. (continued)

Measurement	Location and Comments[a]	Data Acquisition Range[a] Detector	Data Acquisition Range[a] System	Figure[a]	Measurement Comments[b]
Calculated Power (continued)					
KWH*TDC	Total power for high and low power bus.			309	
PUMP CHARACTERISTICS					
Intact Loop					
II*PUMP	Pump current.	125 A	125 A	310	
EI*PUMP	Pump voltage.	500 V	500 V	311	
WI*PUMP	Pump speed.	377 rad/s	377 rad/s	312	
Broken Loop					
EB*PUMP	Pump voltage.	250 V	250 V	313	
KWB*PUMP	Pump power.	82 kW	81 kW	314	
WB*PUMP	Pump speed.	3770 rad/s	3770 rad/s	315	
EXTERNAL BAND HEATER POWER CHARACTERISTICS					
Power Supply 357	Broken loop, pump suction. (spools 27, 28, 29, 37)				
EH*BAND 357	Heater voltage.	200 V	250 V	316	
IH*BAND 357	Heater current.	300 A	400 A	317	
KWBAND357C	Calculated power.			318	
Power Supply 358	Intact loop, pump suction. (spools 7, 8, 9, 10, 11, 12)				
EH*BAND 358	Heater voltage.	200 V	250 V	319	
IH*BAND 358	Heater current.	500 A	400 A	320	
KWBAND358C	Calculated power.			321	
Power Supply 359	Intact loop, cold leg. (spools 14, 15, 16, 17)				
EH*BAND 359	Heater voltage.	200 V	250 V	322	
IH*BAND 359	Heater current.	150 A	200 A	323	
KWBAND359C	Calculated power.			324	
Power Supply 360	Intact loop, hot leg. (spools 1, 2, 3, 4, 5, 6)				
EH*BAND 360	Heater voltage.	200 V	250 V	325	
IH*BAND 360	Heater current.	150 A	200 A	326	
KWBAND360C	Calculated power.			327	
Power Supply 361	Broken loop hot and cold legs. (spools 20, 21, 40, 45)				
EH*BAND 361	Heater voltage.	200 V	250 V	328	
IH*BAND 361	Heater current.	150 A	200 A	329	
KWBAND361C	Calculated power.			330	

a. Statements at the beginning of a measurement category regarding location and comments, range, and figure apply to all subsequent measurements within the given category unless specified otherwise.

b. Detectors which were subjected to overrange conditions during portions of the test were capable of withstanding these conditions without change in operating or measuring characteristics when the physical conditions were again within the detector range.

IV. REFERENCES

1. L. J. Ball et al., *Semiscale Program Description*, TREE-NUREG-1210, May 1978.

2. M. L. Patton, *Semiscale Mod-3 Test Program and System Description*, NUREG-CR-0239, TREE-NUREG-1212, July 1978.

3. R. G. Hanson, *Experiment Operating Specification for Semiscale Mod-2A 5% Break Experiments S-UT-6 and S-UT-7*, EGG-SEMI-5421, April 1981.